

Figure 6.11-15a  
Coefficients (SD1)

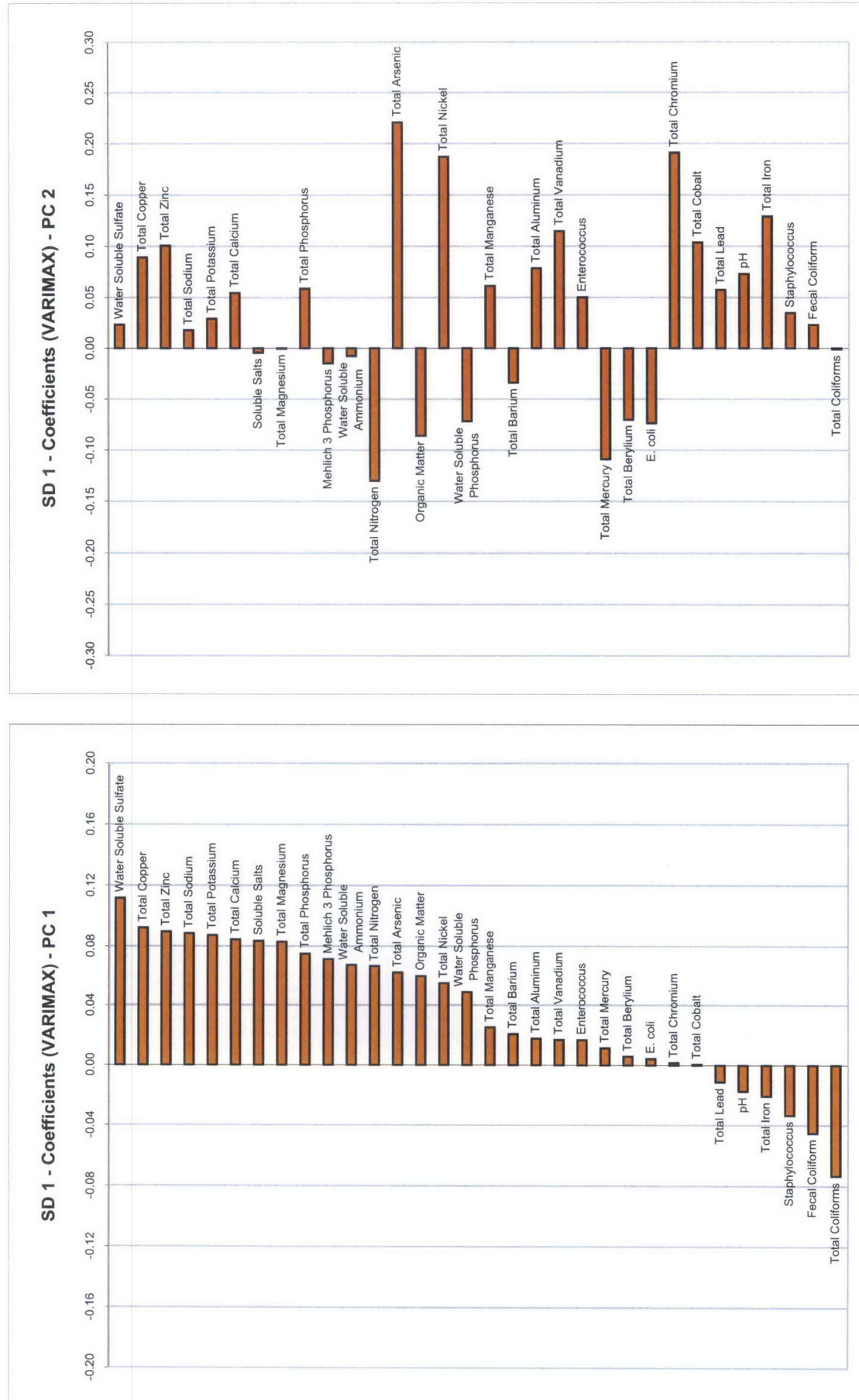


Figure 6.11-15b  
Coefficients (SD1 Varimax)

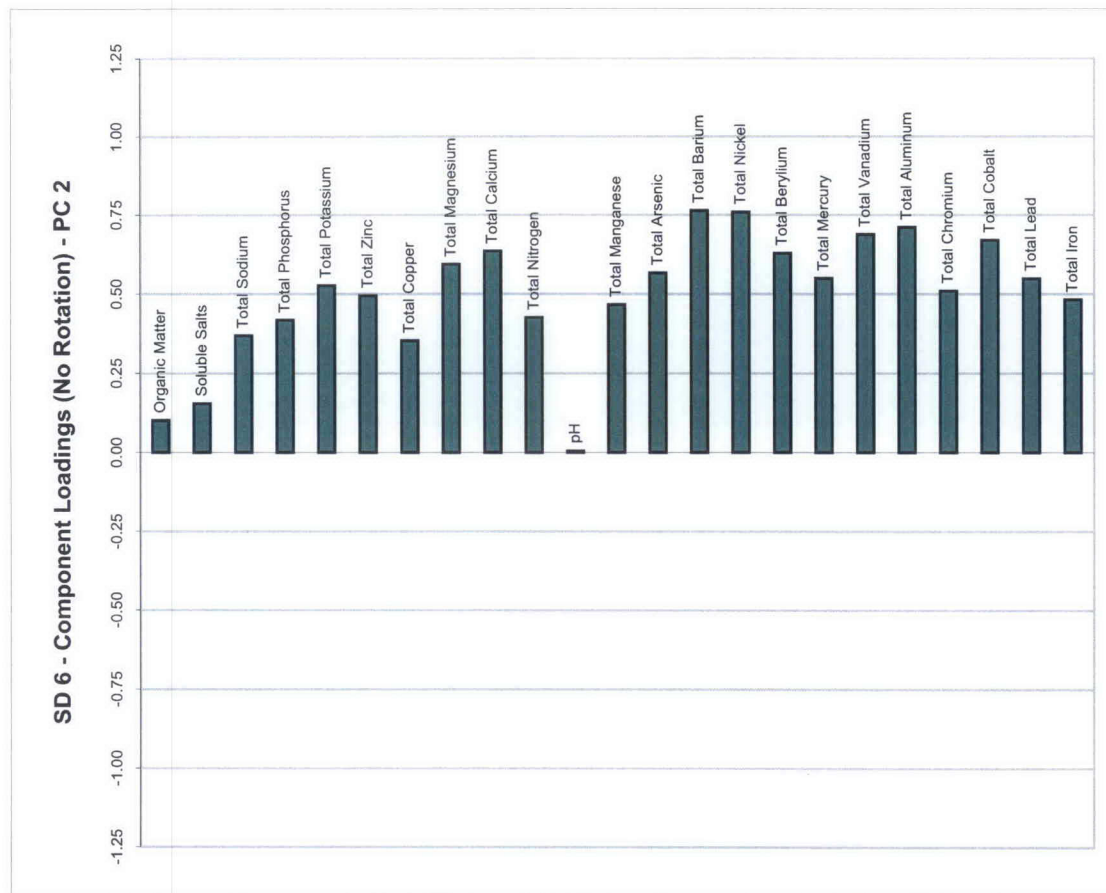
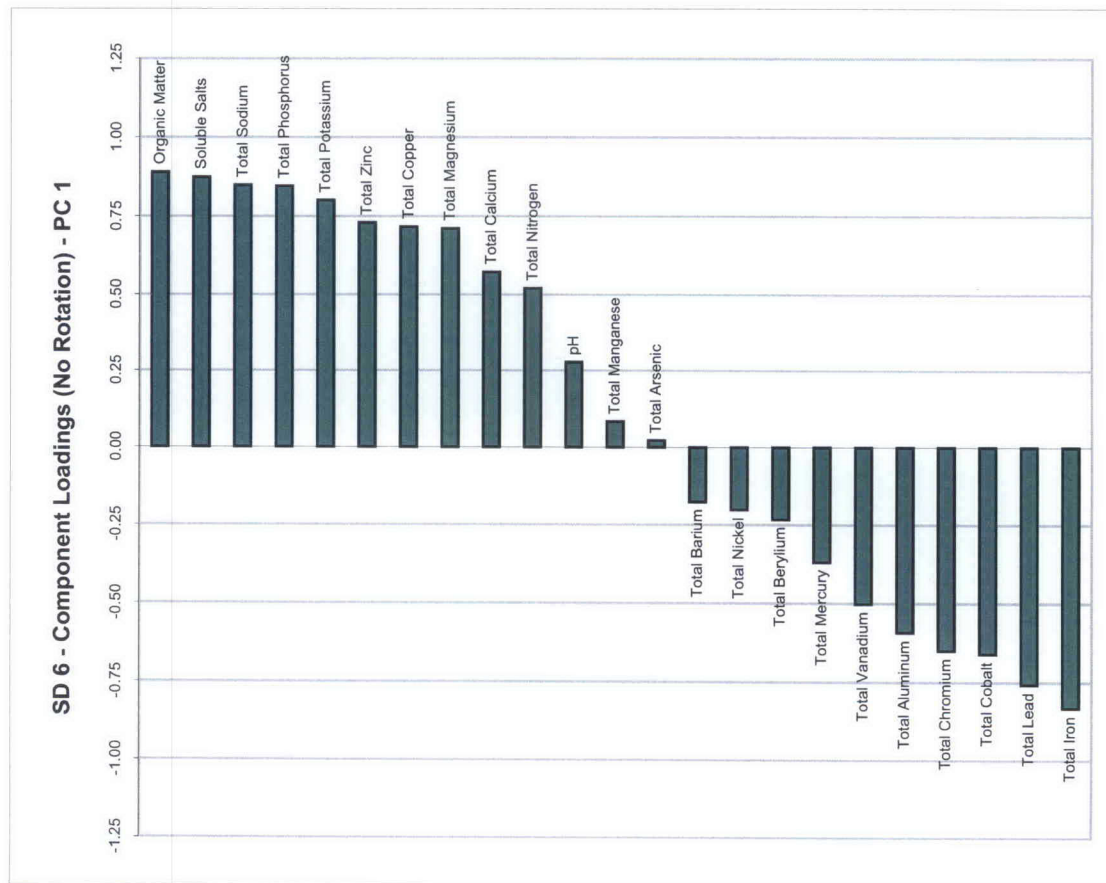


Figure 6.11-16  
Loadings (SD6)

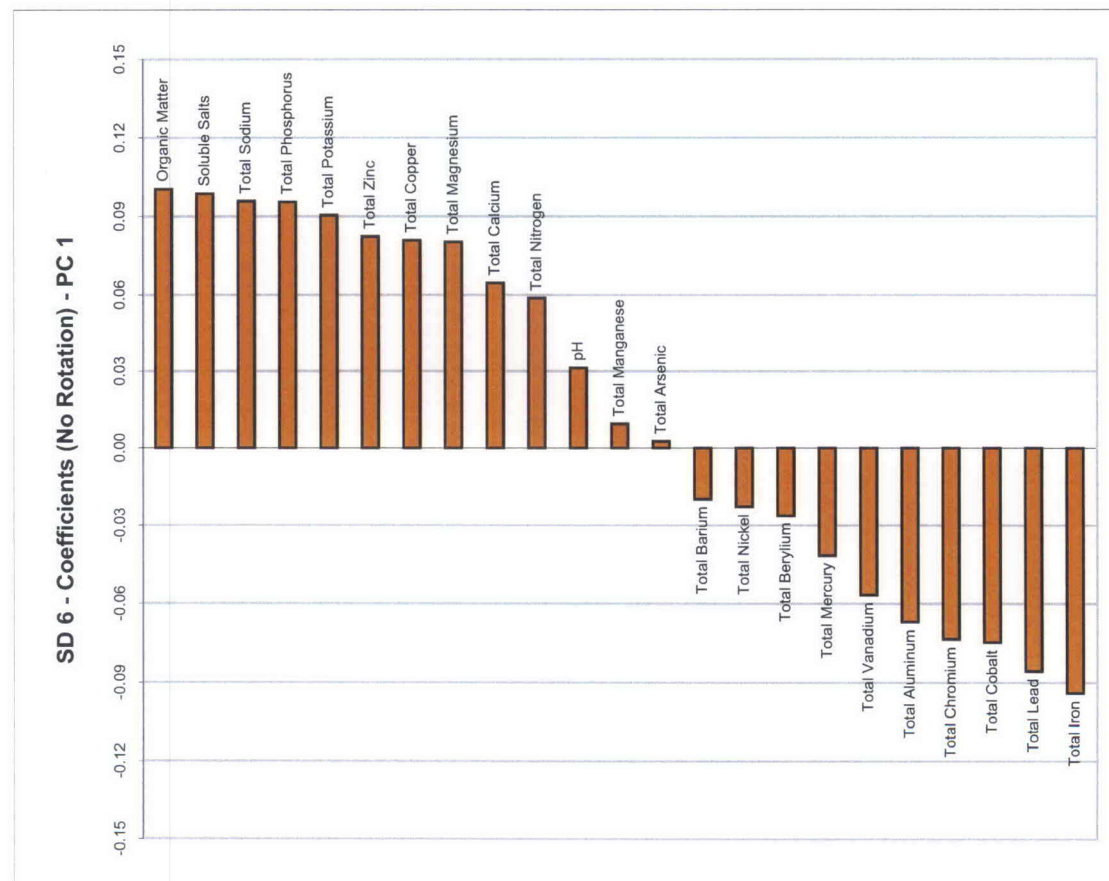
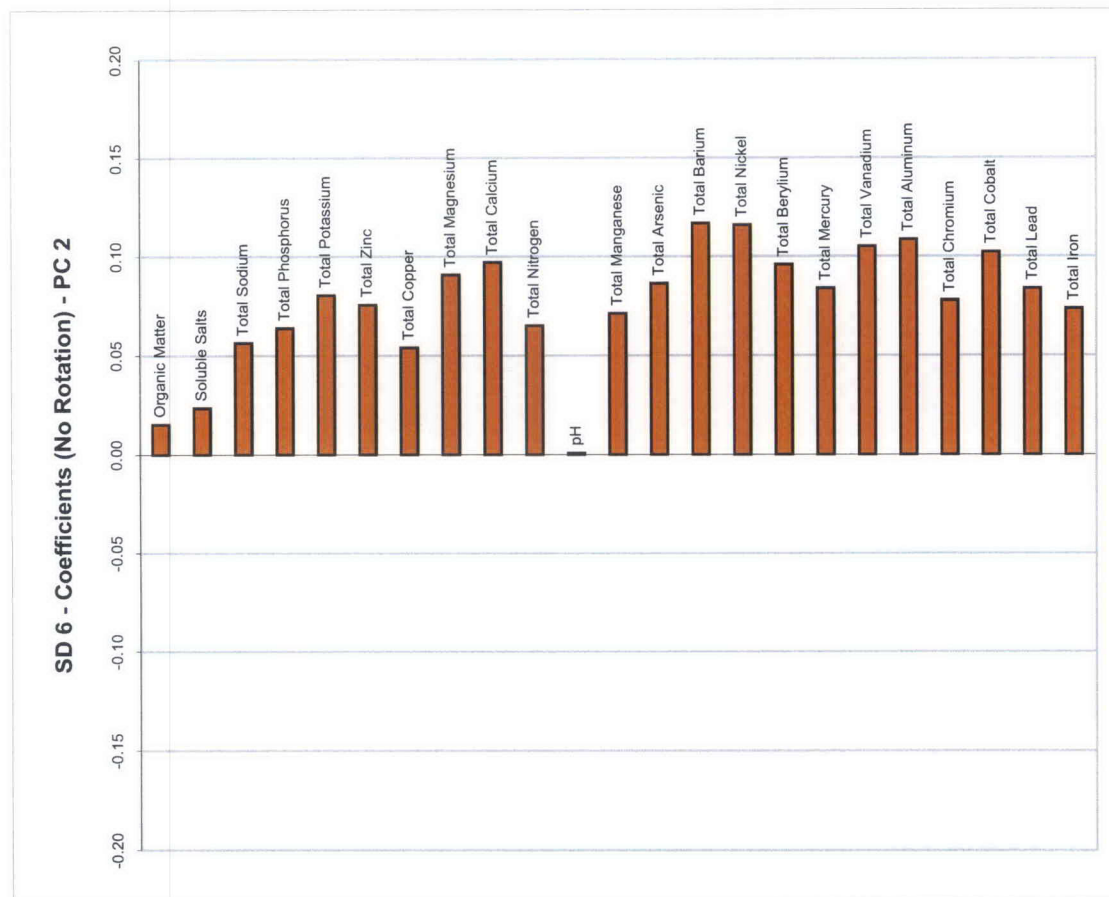


Figure 6.11-17  
Coefficients (SD6)

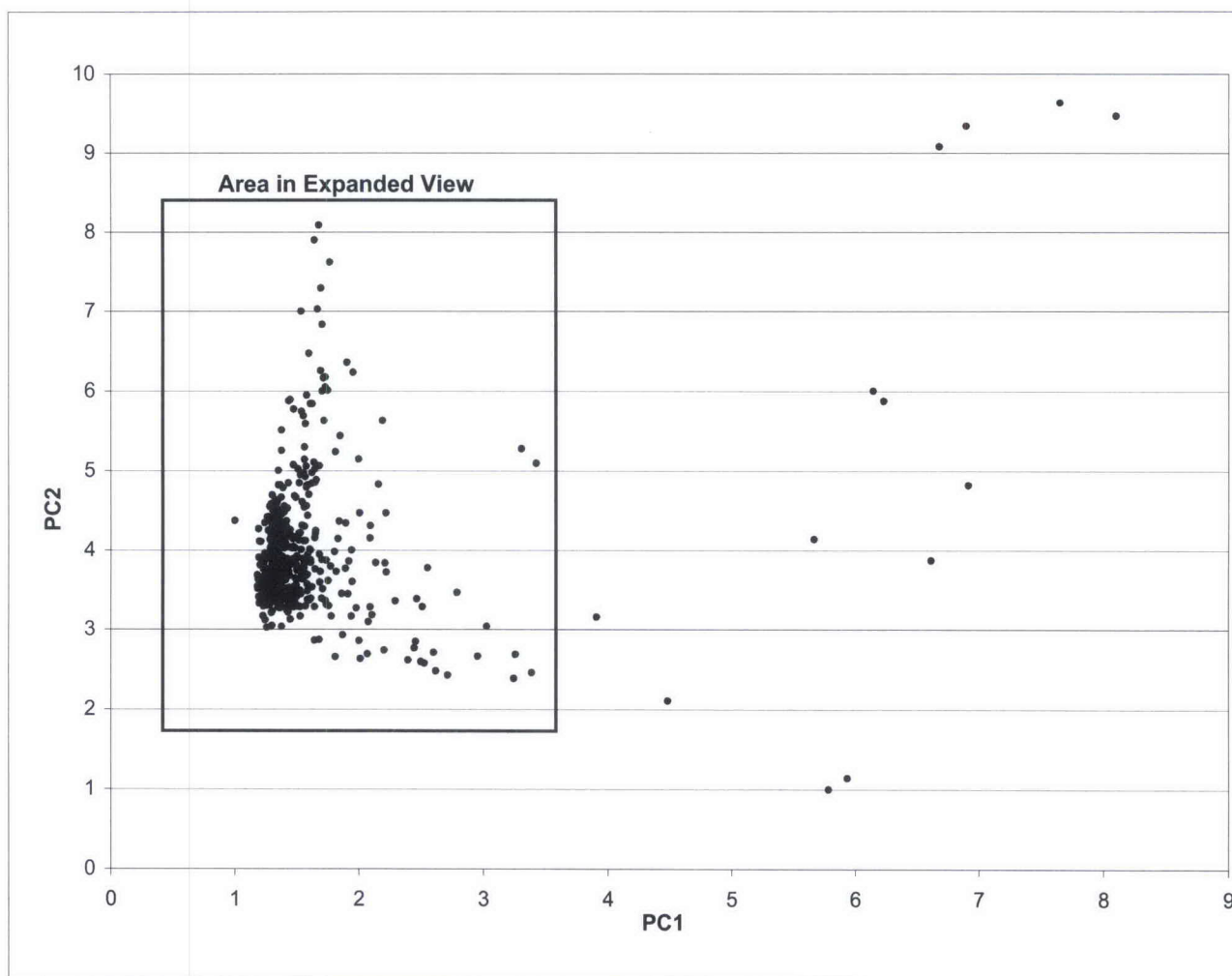


Figure 6.11-18a  
PC1 vs. PC2 Scores: Surface Waters (SW3)

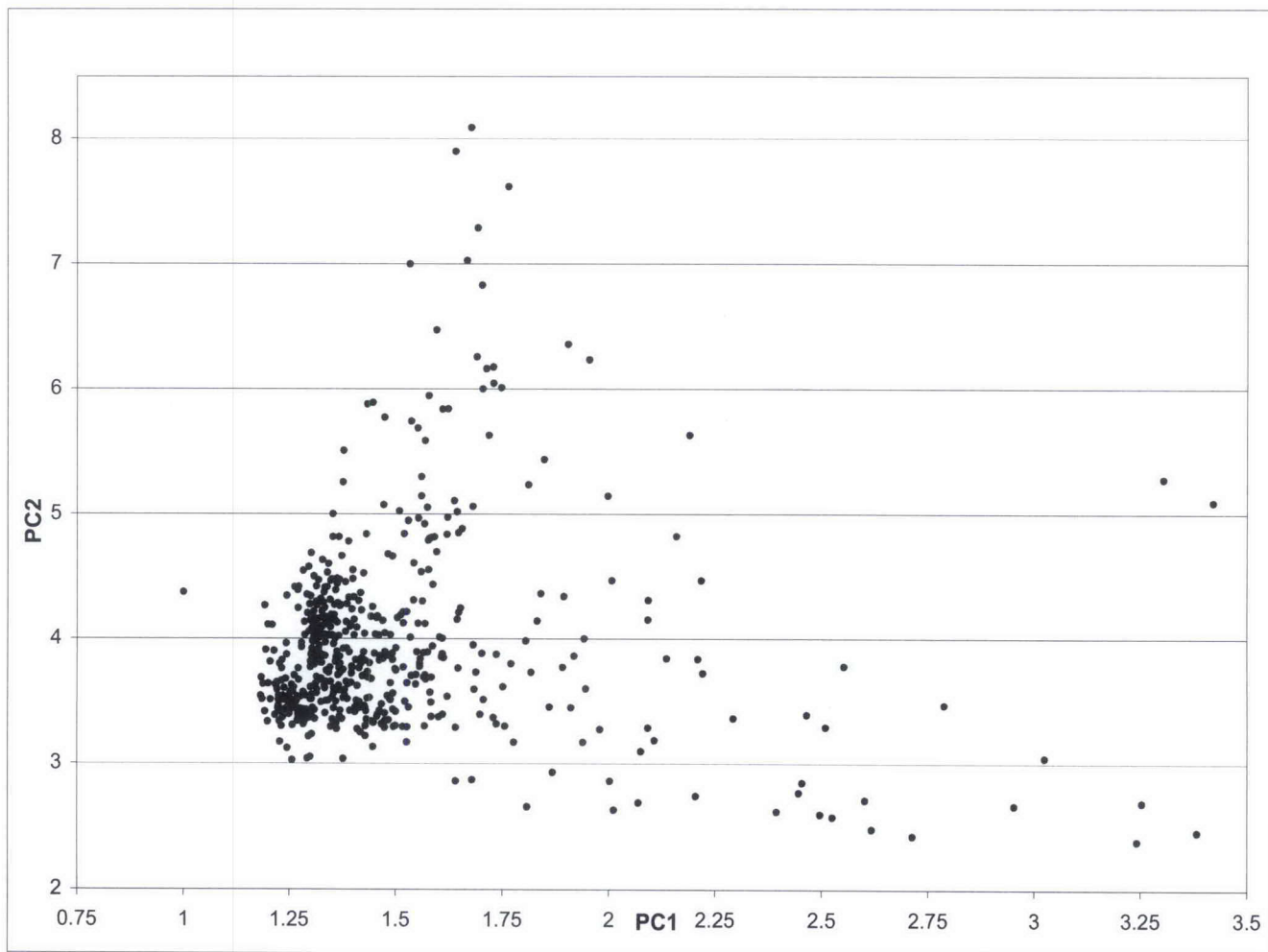


Figure 6.11-18b  
PC1 vs. PC2 Scores: Surface Waters (SW3)

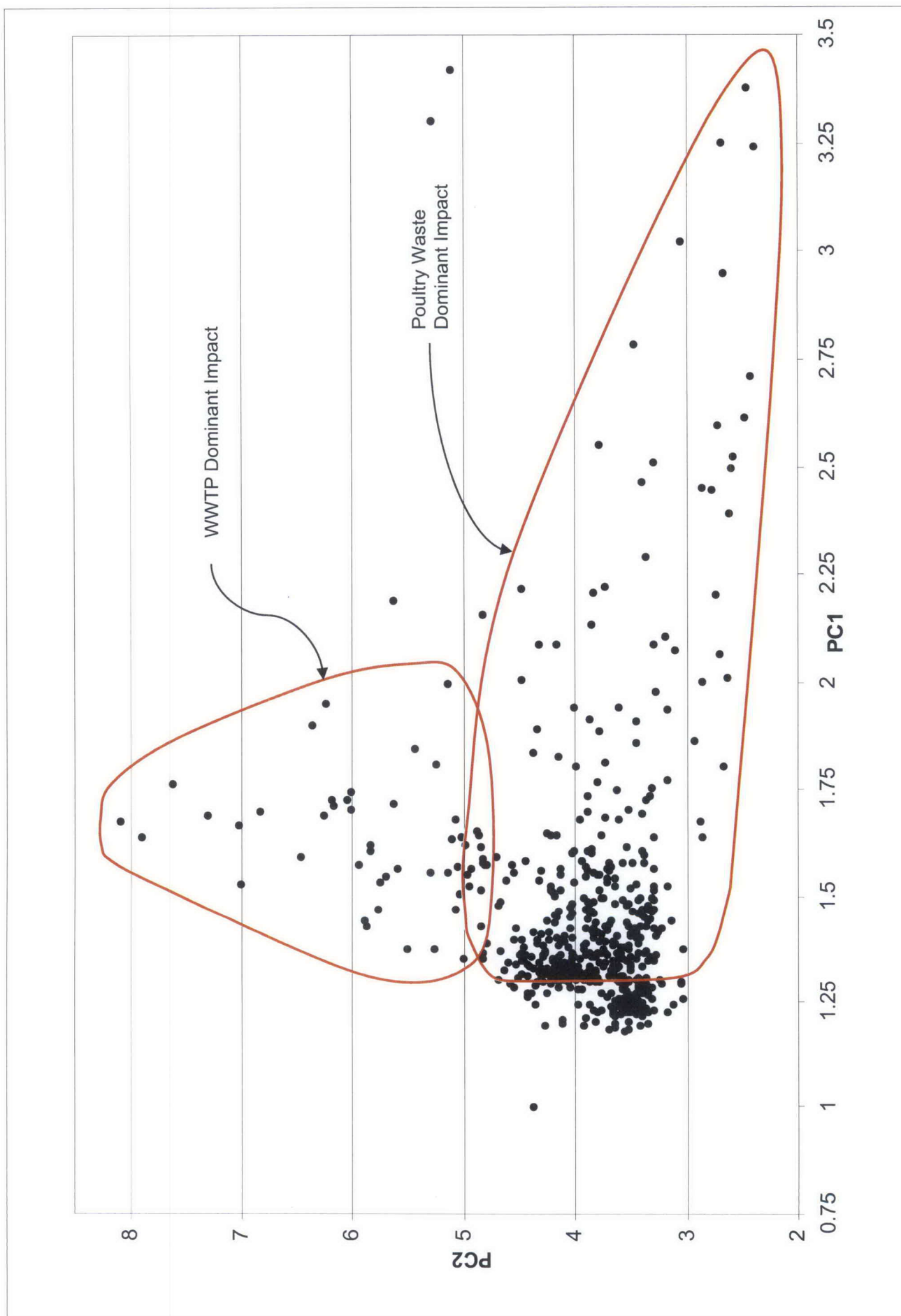


Figure 6.11-18c  
PC1 vs. PC2 Scores: Surface Waters (SW3)

IN THE UNITED STATES DISTRICT COURT FOR THE  
NORTHERN DISTRICT OF OKLAHOMA

W. A. DREW EDMONDSON, in his )  
capacity as ATTORNEY GENERAL )  
OF THE STATE OF OKLAHOMA and )  
OKLAHOMA SECRETARY OF THE )  
ENVIRONMENT C. MILES TOLBERT,) )  
in his capacity as the )  
TRUSTEE FOR NATURAL RESOURCES) )  
FOR THE STATE OF OKLAHOMA, )  
 )  
Plaintiff, )  
 )  
vs. ) 4:05-CV-00329-TCK-SAJ  
 )  
TYSON FOODS, INC., et al, )  
 )  
Defendants. )

-----  
VOLUME I OF THE VIDEOTAPED  
DEPOSITION OF ROGER OLSEN, PhD, produced as a  
witness on behalf of the Defendants in the above  
styled and numbered cause, taken on the 10th day of  
September, 2008, in the City of Tulsa, County of  
Tulsa, State of Oklahoma, before me, Lisa A.  
Steinmeyer, a Certified Shorthand Reporter, duly  
certified under and by virtue of the laws of the  
State of Oklahoma.

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1 all grouped together?

2 A Base flow would not show any effect of stream,  
3 stream bank erosion.

4 Q Was there no difference in the chemical  
5 composition between base flow and high flow samples 10:45AM  
6 in your dataset?

7 A There was, but they all grouped together in  
8 the same pattern.

9 Q What's that pattern?

10 A That's the Principal Component 1 pattern. 10:45AM

11 Q Dr. Olsen, you said you would have seen the  
12 stream bank erosion effect in your analysis. How  
13 would you have seen it?

14 A If it was different and distinct, we would  
15 have seen a different impact on the chemical 10:46AM  
16 composition during high flow versus base flow.

17 Q What would you have expected to have seen in  
18 terms of a different composition?

19 A You know, stream banks would have had more  
20 iron, more aluminum, you know, generally more highly 10:46AM  
21 elements that are in the sediments.

22 Q Okay.

23 A More silica. You know, we didn't analyze for  
24 silica. So more iron, more aluminum. We would have  
25 seen those types of things. 10:46AM

1 the total and if it was, you know, you would have  
2 automatically have 50-50 percent.

3 Q Well, let's get out of the theoretical for the  
4 moment and let's get into the actual data. Could  
5 you turn to Page 3-18. Can you read the second --  
6 in the second paragraph under Section 3-10 the first  
7 full sentence?

11:48AM

8 A The dissolved fraction was greater than the  
9 total fraction for common cations, sodium 55.9  
10 percent, potassium 34 percent and magnesium 38  
11 percent and calcium 42.2 percent, and these are all  
12 cases, particularly sodium and potassium, that  
13 almost all the dissolved -- all the total was equal  
14 to the dissolved. I mean, most of the fraction was  
15 dissolved. So this would be a case where you would  
16 expect higher numbers.

11:49AM

17 Q You would expect the higher number of  
18 dissolved than total?

19 A If they're equal concentrations, you would  
20 expect 50-50.

11:49AM

21 Q Well, but these weren't equal concentrations,  
22 were they?

23 A Well, I'm saying they were almost equal  
24 because sodium is almost always in the soluble  
25 fraction.

11:49AM

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GLENN JOHNSON, PhD, Volume I, 2-24-09

Page 1

IN THE UNITED STATES DISTRICT COURT FOR THE  
NORTHERN DISTRICT OF OKLAHOMA

W. A. DREW EDMONDSON, in his )  
capacity as ATTORNEY GENERAL )  
OF THE STATE OF OKLAHOMA and )  
OKLAHOMA SECRETARY OF THE )  
ENVIRONMENT C. MILES TOLBERT, )  
in his capacity as the )  
TRUSTEE FOR NATURAL RESOURCES )  
FOR THE STATE OF OKLAHOMA, )  
Plaintiff, )  
vs. ) 4:05-CV-00329-TCK-SAJ  
TYSON FOODS, INC., et al, )  
Defendants. )

VOLUME I OF THE VIDEOTAPED

DEPOSITION OF GLENN JOHNSON, PhD, produced as a  
witness on behalf of the Plaintiff in the above  
styled and numbered cause, taken on the 24th day of  
February, 2009, in the City of Tulsa, County of  
Tulsa, State of Oklahoma, before me, Lisa A.  
Steinmeyer, a Certified Shorthand Reporter, duly  
certified under and by virtue of the laws of the  
State of Oklahoma.

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GLENN JOHNSON, PhD, Volume I, 2-24-09

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1 conclusions that he -- that he expressed in his  
2 report.

3 Q So let me ask you, can I follow up on that  
4 particular comment, please?

5 A Certainly. 10:22AM

6 Q Were you asked to do anything else by the  
7 defendants in this case?

8 A That was my major charge. I -- at times I may  
9 have been asked to do other tasks that were related  
10 technically to that. For example, I was asked to 10:22AM  
11 review materials to help Mr. George in preparation  
12 for his deposition of Dr. Olsen, but so I would  
13 consider that a slightly different task but still  
14 part of the same technical umbrella.

15 Q But your focus, if I understand it correctly, 10:22AM  
16 was to evaluate the principal component analysis or  
17 PCA that Dr. Olsen employed --

18 A That's correct.

19 Q -- in his opinion?

20 A I'm sorry. I was talking over you. 10:23AM

21 Q That's okay. And were there any other  
22 analysis or evaluations that you performed for the  
23 defendants that are not found in your report?

24 MR. GEORGE: Object to form.

25 A I looked at some maps of just -- of the -- 10:23AM

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1 just concentrations of certain chemicals in the  
2 watershed.

3 Q Did you prepare any written analysis?

4 A Didn't prepare any written analysis. I

5 believe some of those maps were produced.

10:23AM

6 Q Were they -- what do you mean by maps of  
7 concentrations?

8 A Well, for example, obviously phosphorus is a

9 concern here. So I put together a map of phosphorus

10 concentrations within the watershed so I could just

10:24AM

11 see where the high concentration areas of phosphorus  
12 were located.

13 Q Was that produced as part of your considered  
14 materials?

15 A I believe there's a map in there that shows

10:24AM

16 that, yes.

17 Q Okay, and did you -- did that analysis result  
18 in you forming any opinions?

19 A I'd say -- I'd characterize it supporting my

20 opinion, but it wasn't -- I wouldn't say it was what

10:24AM

21 formed my opinion.

22 Q It supported an opinion that you provided in  
23 your report?

24 A Yes.

25 Q Why did you not then include it in your

10:24AM

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1 A I've been involved in stream studies inland.

2 The Union City is an example. Watershed -- inland

3 watershed of this size, no.

4 Q Have you been to the Illinois River watershed?

5 A Yes.

11:24AM

6 Q When was that?

7 A Mid July of 2008.

8 Q Any other occasions other than last summer in

9 July?

10 A Actually in the watershed, no.

11:24AM

11 Q Okay. When you went to the watershed, did you

12 make any observations?

13 A I was there for a full day. I saw -- I'm not

14 sure what you mean by observations but, yes, I

15 observed a lot.

11:25AM

16 Q Okay, and what did you observe? Did you get

17 like a tour of the watershed?

18 A I got a tour, yes.

19 Q Okay. What were you shown?

20 A We -- on the first day or first part of that

11:25AM

21 day, there was me and two other scientists retained

22 by the defendants whose names I don't recall. We

23 were given a tour of the watershed by air, flying

24 out of Siloam Springs. I don't recall the exact

25 route we took, but I know that we went south and

11:25AM

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1 west over Lake Tenkiller and back up towards  
2 Fayetteville to the east of Siloam and eventually  
3 back to the airport.

4 Q How would you characterize the land use as you  
5 observed from the air on this trip?

11:26AM

6 MR. GEORGE: Object to form.

7 A I saw wooded areas. When we were over  
8 Fayetteville, I saw urban areas. When we were over  
9 the lake, I saw wooded and agricultural. I saw  
10 agricultural in the -- agricultural in a number of  
11 places as well.

11:26AM

12 Q Would you characterize as most of the  
13 watershed you observed was either agricultural  
14 pasture or forest?

15 MR. GEORGE: Object to form.

11:26AM

16 A I was not calculating percentages in my mind,  
17 but there was a lot of agricultural and forest.

18 Q Do you have any knowledge of what the relative  
19 percentages are of land uses within the IRW?

20 A Not of an exact percent, no.

11:27AM

21 Q Is that type of information helpful in source  
22 identification projects?

23 MR. GEORGE: Object to form.

24 A It certainly could be if you're -- yes, it  
25 certainly could be.

11:27AM

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GLENN JOHNSON, PhD, Volume II, 2-25-09

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IN THE UNITED STATES DISTRICT COURT FOR THE  
NORTHERN DISTRICT OF OKLAHOMA

W. A. DREW EDMONDSON, in his )  
capacity as ATTORNEY GENERAL )  
OF THE STATE OF OKLAHOMA and )  
OKLAHOMA SECRETARY OF THE )  
ENVIRONMENT C. MILES TOLBERT,) )  
in his capacity as the )  
TRUSTEE FOR NATURAL RESOURCES) )  
FOR THE STATE OF OKLAHOMA, )  
 )  
Plaintiff, )  
 )  
vs. ) 4:05-CV-00329-TCK-SAJ  
 )  
TYSON FOODS, INC., et al, )  
 )  
Defendants. )

-----  
VOLUME II OF THE VIDEOTAPED  
DEPOSITION OF GLENN JOHNSON, PhD, produced as a  
witness on behalf of the Plaintiff in the above  
styled and numbered cause, taken on the 25th day of  
February, 2009, in the City of Tulsa, County of  
Tulsa, State of Oklahoma, before me, Lisa A.  
Steinmeyer, a Certified Shorthand Reporter, duly  
certified under and by virtue of the laws of the  
State of Oklahoma.

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1 of this exhibit.

2 A The title is Summary of Edge of Field Poultry  
3 Samples.

4 Q Okay. Do you recall that there were a summary  
5 of the edge of field poultry samples in Appendix C  
6 of Dr. Olsen's report?

01:48PM

7 A I recall it now that I look at it.

8 Q Okay.

9 MR. GEORGE: David, is it your  
10 representation that Exhibit 24 is an exact copy of  
11 what was exhibit -- I'm sorry, Appendix C to Dr.  
12 Olsen's report?

01:49PM

13 MR. PAGE: Yes.

14 MR. GEORGE: Okay. What threw me was the  
15 header at the top that says draft, do not produce.  
16 I don't recall seeing that on his report but maybe  
17 it was.

01:49PM

18 MR. PAGE: I don't recall either. My  
19 understanding, this is a copy of exactly what's in  
20 Appendix C of his report, Table 1.

01:49PM

21 Q Would you look at the total suspended and  
22 total dissolved solids, sir, under average?

23 A The highlighted section?

24 Q Yes, sir.

25 A Okay. I'm looking at it.

01:49PM

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1 Q Okay. What is the total dissolved solids?

2 A 405.25.

3 Q And total suspended solids are what level?

4 A 267.984.

5 Q With regard to the total suspended solids,

01:49PM

6 would you characterize those as being the -- I'm

7 going to use it loosely -- but the muddy

8 characterization?

9 A Yes, using that term loosely.

10 Q You would say --

11 A The higher total suspended solids implies

12 higher turbidity, which would be characterized as

13 muddier.

14 Q And would you be able to tell if this water --

15 would this water appear muddy or clear at 267.984

01:50PM

16 TSS?

17 A I don't know visually how that number would

18 compare. I don't know how that number would compare

19 to a visual observation of the sample.

20 Q You haven't taken samples before where you

01:50PM

21 noticed the TSS and then observed whether the water

22 appeared to be cloudy or clear?

23 A I probably have at some point in my career. I

24 don't remember where the number 267 would have

25 fallen in one those observations.

01:50PM

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1 Q Okay. What about in your total dissolved  
2 solids; would that be within the area of salty in  
3 your analysis?

4 A Well, going back to -- okay. The top bin for  
5 total sodium plus potassium plus chloride plus 01:51PM  
6 sulfate -- well, that's -- there's more to total  
7 dissolved solids than just those four, but those on  
8 their own, the top bin of this graph is greater than  
9 300 milligrams per liter. So this 405, to the  
10 extent that total dissolved solids can be taken -- 01:52PM  
11 that these four analytes can be taken as a proxy for  
12 total dissolved solid, this looks to be on the high  
13 end of the range.

14 Q Okay. Can I ask you, sir, to look at the  
15 total P using method 4500 and using total dissolved 01:52PM  
16 total P using 4500, and could you give me those two  
17 averages, please?

18 A You want me to average the two values?

19 Q Well, I think the average values are provided  
20 for you there. 01:52PM

21 A Oh, I see. Total dissolved P by 4500 PF is  
22 4.8239. Total phosphorus by 4500 PF is 8.1395.

23 Q So what would be -- would the approximate  
24 dissolved phase of phosphorus be equal to about 59  
25 percent of the total phosphorus in this particular 01:53PM

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1 sample, on these edge of field samples?

2 MR. GEORGE: You're referring to the  
3 average, David?

4 MR. PAGE: Yes.

5 A It appears to be greater than half. So 59, I 01:53PM  
6 would have no reason to question that number.

7 Q Given that level of dissolved phase  
8 phosphorus, would that indicate that at least  
9 leaving the fields, there's still a substantial  
10 amount of dissolved phosphorus in the system? 01:53PM

11 MR. GEORGE: Object to form.

12 A I'm sorry. I didn't -- I faded on the  
13 question. Could you --

14 Q I apologize. I probably faded when I --  
15 (Whereupon, the court reporter read 01:53PM  
16 back the previous question.)

17 A Well, to the extent that these edge of fields  
18 represent what is truly leaving a field. I know  
19 there are some people on our side that have -- that  
20 have questions about whether or not that's 01:54PM  
21 representative of the water leaving the field, but  
22 taking that at face value, yes.

23 Q Are you going to be giving any testimony about  
24 what is and what isn't representative in the edge of  
25 field samples? 01:54PM

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1 A I will not.

2 Q Did you review any of those reports?

3 A No, I did not.

4 Q So you're just kind of speculating on --

5 A No. I'm aware that there are others on the 01:54PM  
6 defense side expert team that are doing a lot more  
7 than speculating.

8 Q But you didn't review any of the information?

9 A I was not asked to, no.

10 Q So you're confident in this kind of setting to 01:54PM  
11 represent that's what the findings are going to be  
12 of what's going to be presented by the defendants in  
13 this case?

14 MR. GEORGE: Object to form.

15 A I don't believe I said that. I -- 01:54PM

16 Q Well, you kind of volunteered something kind  
17 of arguing that --

18 A Well, I've -- a number of times during this  
19 deposition over the last two days where I've been  
20 asked opinions on issues that I'm aware others on 01:55PM  
21 the defense expert team have been asked to address  
22 that I was not asked to address, and I guess I'm  
23 bristling at the implement -- implication that  
24 perhaps this is stuff that was never looked at.

25 Q Well, if I would have just said to you, sir, 01:55PM

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1 rather than -- that there's -- this data indicates  
2 there's a large component of dissolved phase in edge  
3 of field samples that are in Dr. Olsen's report,  
4 would you feel better about answering that question?

5 A Yes, absolutely.

01:55PM

6 Q Okay. Thank you. So your answer is yes to my  
7 question?

8 A To that question, yes.

9 Q Thank you. Let's skip back two more pages to  
10 base flow conditions, please, sir. Could you read  
11 what the table title is, sir? That's on Page 4 of  
12 exhibit.

01:55PM

13 A Summary of Small Tributary Samples Base Flow  
14 Conditions.

15 Q Okay. Do you have an understanding of what  
16 small tributary samples base flow conditions are?

01:56PM

17 A Well, base flow would be -- I don't know if  
18 there's a number that they use to demarcate the  
19 difference between base flow and high flow, but  
20 generally lower flow is what they consider base  
21 flow. Small tributaries would be streams that were  
22 the smaller streams, not like the Illinois River, or  
23 probably even the secondary streams.

01:56PM

24 Q Okay, and what's the total suspended solids  
25 average value for those types of samples?

01:56PM

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1 A 6.8958.

2 Q At that level of TSS, would you expect there  
3 to be sufficient particulates to create an  
4 adsorption of phosphorus?

5 MR. GEORGE: Object to form.

01:56PM

6 A Well, there are particulates where it wouldn't  
7 -- where it would be zero. Total suspended solids  
8 does not equal zero.

9 Q Right, but would you tend to believe that  
10 where you have TSS at 6 -- let's say 7 milligrams  
11 per liter, that there would be sufficient  
12 particulates to affect an adsorption phenomena that  
13 you're claiming is occurring in PC1 between the  
14 particulates and phosphorus?

01:57PM

15 MR. GEORGE: Object to form.

01:57PM

16 A To the extent that there are suspended solids  
17 in the samples that contributed to this average, I  
18 don't think -- even if they're a relatively low  
19 concentration, it would not be my understanding that  
20 because there's a lower concentration of total  
21 suspended solids that they were somehow exempt from  
22 the processes of adsorption and desorption.

01:57PM

23 Q And what was the average pH for the base flow  
24 samples?

25 A pH?

01:58PM

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1 Q Yes.

2 A Is that highlighted or is this someplace else  
3 in the table?

4 Q It's at the bottom line. I don't believe I've  
5 highlighted this one.

01:58PM

6 A Oh. 7.4673.

7 Q And would that be a pH that would create an  
8 affinity for adsorption between particles and  
9 dissolved fraction of phosphorus?

10 A I don't know.

01:58PM

11 Q Okay. How much phosphorus can 7 milligrams  
12 per liter of TSS adsorb?

13 A I don't -- I couldn't give you a number.

14 Q Okay. Would you take a look at the total  
15 dissolved phosphorus under 4500 method and total  
16 phosphorus for 4500 and give me -- and read those  
17 for the Record, please.

01:58PM

18 A Total dissolved phosphorus, 2.873.

19 Q Excuse me. Did you mean to say .2873?

20 A Yes, I did. I'm sorry if I did not say that.

01:59PM

21 0.2873.

22 Q Okay, and what about total phosphorus?

23 A 0.337.

24 Q Would that -- would the dissolved-to-total  
25 phosphorus fraction be about 85 percent in these

01:59PM

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1 stream samples on average?

2 A Comparing those numbers, that seems about  
3 right.

4 Q So there's a substantial amount of dissolved  
5 phase phosphorus in base flow stream samples that  
6 were collected in the IRW; is that correct?

01:59PM

7 A Appears so, to the extent that these averages  
8 are representative of the dataset as a whole.

9 Q I see that we're short to a break. So let's  
10 take a break at this time.

01:59PM

11 VIDEOGRAPHER: We are now off the Record.  
12 The time is 1:59 p.m.

13 (Following a short recess at 1:59 p.m.,  
14 proceedings continued on the Record at 2:19 p.m.)

15 VIDEOGRAPHER: We are now on the Record.  
16 The time is 2:19 p.m.

02:19PM

17 Q Dr. Johnson, I'd like to continue with -- I  
18 think it's Exhibit 24.

19 A Yes, I have that.

20 Q Would you turn to Page 6 and tell the court  
21 the title of the -- the type of samples that are  
22 represented on Page 6.

02:19PM

23 A Title at the top says High Flow Conditions,  
24 Small Tributaries High Flow Conditions.

25 Q So we just looked at small tributaries, low or

02:19PM

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1 base flow, and now we're looking at small

2 tributaries high flow; correct?

3 A Yes.

4 Q Okay. What's the TSS level, average level for

5 this particular --

02:19PM

6 A 11 --

7 Q -- group of samples?

8 A I'm sorry. Are you finished? 11.2712.

9 Q Would you consider that a low TSS number?

10 A Within the ranges of the data in SW3, I would

02:20PM

11 call it moderate. It's not -- on this figure that I

12 have, 4-8, it's colored. That would end up being

13 plotted as a green symbol, which would be in the

14 middle of the range.

15 Q From your perspective of your knowledge of TSS

02:21PM

16 levels in ambient waters, would you consider that a

17 high TSS level?

18 A I'm not familiar with how total suspended

19 solids in other watersheds would compare with the

20 data we're seeing here. I don't know if it would be

02:21PM

21 considered high or low.

22 Q Really? Would you consider that to be a

23 sufficient TSS to be a muddy water?

24 A Again, I would echo the answers that I gave

25 with response to any specific value, and I'd be glad

02:21PM

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1 to go through that whole soliloquy again, but I  
2 indicated that there is no threshold where we cross  
3 the boundary from not muddy to muddy. This would  
4 fall along that continuum.

5 Q Would you consider these waters appear to be 02:21PM  
6 clear based on your experience?

7 A It's closer to the bottom of the TSS range  
8 than it is to the top.

9 Q Have you seen an unimpacted Ozark stream?

10 MR. GEORGE: Object to form. 02:22PM

11 A Ozark?

12 Q Yes.

13 A Would that be someplace other than the  
14 Illinois River watershed?

15 Q No. I think it would be characterized -- 02:22PM

16 A So the Ozarks are -- the Illinois River is  
17 part of the Ozarks.

18 Q Yeah, I believe so.

19 A I was aware that west -- east of Fayetteville  
20 is also the Ozarks. We observed a number of streams 02:22PM  
21 while I was on my -- the site visit in July. The  
22 extent to which I would characterize it impacted or  
23 not impacted, I can't say.

24 Q Did you notice whether the water was clear or  
25 not? 02:22PM

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1 A I know that there were locations where I could  
2 see the bottom of the stream.

3 Q In that locations that you could not, was it  
4 because the water had kind of a greenish hue to it?

5 MR. GEORGE: Object to form.

02:23PM

6 A At Lake Tenkiller I remember I could see the  
7 bottom near the shore, and I couldn't see the bottom  
8 obviously when it got deeper. I don't know if  
9 that's because of a greenish hue or because the  
10 depth of the water.

02:23PM

11 Q Would you read for the Record the dissolved P  
12 method 4500 and the total phosphorus at the 4500?

13 A You mean the average concentrations for those  
14 two?

15 Q Yes, sir. I'm just going to focus on average  
16 concentration for this line of questions.

02:23PM

17 A Total dissolved P by 4500 PF, 0.2932. Total P  
18 by 4500 PF, 0.3117.

19 Q Would you estimate that the fraction of  
20 dissolved P would be greater than 90 percent in  
21 these samples?

02:23PM

22 A Around 90 looks to be a reasonable estimate.

23 Q Wouldn't that tend to negate your hypothesis  
24 that there's an affinity of phosphorus for total  
25 suspended solids in this system?

02:24PM

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1 MR. GEORGE: Object to form.

2 A You previously -- this means that, if I'm  
3 reading this data correctly, the majority of the  
4 phosphorus in these samples is total dissolved.

5 Q Yes. 02:24PM

6 A And we have total suspended solids, which is  
7 on the low end. So I think this would be consistent  
8 with what I concluded in -- the samples to the left  
9 side of this graph tend to have lower total  
10 phosphate and -- I'm not sure I understand the 02:24PM  
11 question.

12 Q Well, doesn't this indicate, sir, that there  
13 isn't a lot of adsorption going on in small  
14 tributaries during high flow conditions?

15 MR. GEORGE: Object to form. 02:25PM

16 A We have both low total phosphate and we have  
17 relatively low total suspended solids. So for  
18 samples within that range of total suspended solids,  
19 I would agree with that.

20 Q And the sample type, which would be small 02:25PM  
21 tributary types high flow conditions?

22 A To the extent that these averages of over a  
23 hundred are representative of the dataset as a  
24 whole. I would imagine that this is not a uniform  
25 -- that these means are not narrowly calculated 02:25PM

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1 around the 11.2712. I'd be curious to see a  
2 histogram that shows the full distribution of total  
3 suspended solids to see how representative that  
4 11.27 is.

5 Q Is it your opinion, sir, that total dissolved 02:25PM  
6 solids -- excuse me -- total dissolved phosphorus in  
7 an Illinois River stream is low at .2932 parts per  
8 million?

9 A I don't know what number I would put on low  
10 versus not low. The .2 -- what number did you say? 02:26PM

11 Q I'm just reading the average here as .2932. I  
12 thought I heard you say that you characterized these  
13 phosphorus levels as low.

14 A Low in the context of the --

15 Q Well, it's low in the context we looked at for 02:26PM  
16 edge of field?

17 A Yes, yes.

18 Q And edge of field was 8.4.

19 A I forget what number is the -- is considered,  
20 and I don't know even know they use this term, an 02:26PM  
21 action level, so I'm not sure where the .2932 fits  
22 in that scale.

23 Q Do you know what the action level is for  
24 phosphorus in the IRW according to Oklahoma law?

25 MR. GEORGE: Object to form. 02:27PM

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1 A No, I don't.

2 Q Would it surprise you to know it was .037?

3 MR. GEORGE: David, are you representing  
4 that's an action level?

5 MR. PAGE: Well, I'm just using his 02:27PM  
6 terminology.

7 MR. GEORGE: Well, are you -- you said did  
8 you know the action level is.

9 A And I prefaced action level saying I don't  
10 know if this is an accurate term. 02:27PM

11 Q Well, do you mean by like a phosphorus  
12 criteria?

13 A Yeah.

14 Q Okay. Yes, I'm representing that 0.37 is the  
15 phosphorus criteria for scenic rivers in the 02:27PM  
16 Illinois River watershed.

17 A Yes, that would be above that. The .2392  
18 would be above that level.

19 Q Well above it; correct?

20 A Yes.

21 Q So in that context, it wouldn't be a low level  
22 of phosphorus, would it?

23 A You are correct.

24 Q Can we turn a couple more pages to Page 8, and  
25 does it not say at the top that these are the group 02:27PM

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1 of samples that are collected at surface water  
2 rivers and base flow?

3 A Yes.

4 Q Okay, and, again, could you tell the court  
5 what the total suspended solids level is?

02:28PM

6 MR. GEORGE: The average?

7 MR. PAGE: Yes, the average.

8 A Average of 124 samples, 5.0161.

9 Q Okay, and could you again for my benefit read  
10 the total fraction or total phosphorus under 4500  
11 method and then the dissolved fraction?

02:28PM

12 A Total P, 0.1466; total dissolved P, 0.1183.

13 Q Okay. Would that be approximately 80 percent  
14 dissolved fraction of all the phosphorus that's  
15 represented by these samples?

02:28PM

16 A 80 percent looks like a good estimate.

17 Q Does the level of total suspended solids  
18 indicate that there would be very little adsorption  
19 of dissolved phosphorus in samples of the type that  
20 are represented on Page 8?

02:29PM

21 MR. GEORGE: Object to form.

22 A Yes, compared to dissolved.

23 Q Would you turn now a couple more pages over to  
24 Page 10 of this exhibit where at the top it says  
25 Rivers High Flow. We looked at the base flow. Now

02:29PM

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1 we're looking at the high flow rivers.

2 A We've already looked at base flow and high  
3 flow in previous tables. I'm unsure -- what's the  
4 difference that we've made between the earlier base  
5 flow and high flow and the tables we're looking at  
6 now?

02:29PM

7 Q The earlier ones were small tributary samples  
8 and then this is now --

9 A Larger water bodies, plus lakes?

10 Q Yeah. Clearly this -- we're looking at a  
11 gradient or a component from the edge of field to  
12 small tributaries to the large rivers.

02:29PM

13 A I think I understand.

14 Q Okay.

15 A Which page again? I'm sorry. I flipped back.

02:30PM

16 Q Page 10.

17 MS. COLLINS: Is that Table 5?

18 MR. PAGE: This is called Table 6.

19 Q What's the TSS average shown on Page 10 for  
20 rivers high flow?

02:30PM

21 A 15.25 milligrams per liter.

22 Q Would you consider that a level of TSS that  
23 would be -- cause the waters to be cloudy?

24 A Again, same answer as previously. It falls  
25 within -- the range of my Figure 4-8, a sample of

02:30PM

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1 that TSS would be plotted green, which is moderate  
2 in terms of that range of values from low to high  
3 TSS. I don't know if visually that would end up  
4 being a cloudy sample or not.

5 Q You don't know whether you could see 15.25 02:31PM  
6 milligrams per liter TSS in a water sample?

7 A No, I don't.

8 Q Would you again for me, sir, identify the  
9 averages for total P and total dissolved P for  
10 methods 4500? 02:31PM

11 A Total P, 0.1186; total dissolved P, 0.0855.

12 Q Does that appear that the dissolved fraction  
13 is about 75 percent of the total fraction?

14 A It seems like a good estimate.

15 Q Does that appear that there's little 02:31PM  
16 adsorption going on in these samples?

17 MR. GEORGE: Object to form.

18 A Appears that the majority would be in the  
19 dissolved phase.

20 Q So there's not much of an affinity -- would 02:32PM  
21 you believe there's not much of an affinity between  
22 the phosphorus and TS -- excuse me -- total  
23 suspended solids --

24 A I think it indicates the majority is in the  
25 dissolved phase. I would not say that what 02:32PM

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1 particulates are there would not show an affinity  
2 for phosphorus. It's just that there are low  
3 concentrations of suspended solids.

4 Q Are there sufficient TSS or suspended solids  
5 to transform the total dissolved phosphorus into  
6 particulate phase?

02:32PM

7 A No. The majority here is still total  
8 dissolved.

9 Q Would you look over to Page 12, sir, and at  
10 the top does it not say USGS sampling base flow?

02:32PM

11 A Yes.

12 Q Do you understand what type of samples were  
13 collected by the United States Geological Service in  
14 this matter?

15 A Not entirely. I understand that there were  
16 samples collected at USGS stations in addition to  
17 the ones that CDM collected.

02:33PM

18 Q Did you understand they're large -- they're  
19 collected in areas of large stem river?

20 A Large -- excuse me?

02:33PM

21 Q Large stem river.

22 MR. GEORGE: Object to form.

23 A I did not recall that that was what their  
24 sampling locations were limited to.

25 Q Okay. What's the total suspended solids

02:33PM

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1 concentrations average shown by the USGS samples for  
2 base flow?

3 A Well, this one is listed as suspended sediment  
4 concentration rather than total suspended solids.

5 I'm not sure if that means it's a completely 02:33PM  
6 different analyte or not, but the number is 7.5532  
7 milligrams per liter.

8 Q Okay, and what is the total dissolved solids  
9 average shown on this page?

10 A I don't see total dissolved solids on this 02:34PM  
11 page.

12 Q Have you ever looked at USGS analytical data  
13 in the past?

14 A I've looked at the USGS data that came into  
15 the dataset -- 02:34PM

16 Q Let me ask you --

17 A -- into the SW3 dataset.

18 Q Okay. Have you ever looked at it from the  
19 USGS report?

20 A I don't recall if I downloaded one of those 02:34PM  
21 reports or not. If I did, I was not looking to see  
22 if they were listing total dissolved solids under  
23 some other name.

24 Q Have you ever reviewed any USGS data prior to  
25 this case? 02:34PM

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1 A You mean any USGS data regardless of whether  
2 it was metals or water or Illinois River?

3 Q Water sampling data from the USGS.

4 A From any basin?

5 Q Yes.

02:35PM

6 A I don't recall looking at this type of water  
7 data.

8 Q Would you recall if I suggested to you that  
9 the total dissolved solid is a residue on  
10 evaporation in USGS parlance?

02:35PM

11 A Yes, that would be reasonable to assume. So  
12 residue on evap, that variable, are you representing  
13 that's essentially the same value as total dissolved  
14 solids?

15 Q Yes, sir.

02:35PM

16 A Okay.

17 Q So what is that value?

18 A 177.533.

19 Q Would you characterize this as a salty --

20 salty waters from your analysis? I believe you said  
21 before it was above around 300; correct?

02:35PM

22 A Assuming the residue on evaporation would have  
23 been dominated by potassium, sodium, chloride and  
24 sulfate, I think this would put it up near the --  
25 the top end of the range of the samples that I

02:36PM

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1 plotted here. That would put it into the color  
2 range of orange on this. So not the highest that we  
3 see but higher than most.

4 Q All right, and would you please tell the court  
5 what the total phosphorus values are, average values  
6 for this dataset and the dissolved phosphorus?

02:36PM

7 A Total phosphorus, 0.163. Dissolved phosphorus  
8 is 0.1573, both units -- units for both milligrams  
9 per liter.

10 Q Does that appear to you, sir, to be about 90  
11 percent of the phosphorus in this dataset to be in  
12 the --

02:36PM

13 A That looks to be a reasonable estimate.

14 Q -- in the dissolved phase?

15 A I'm sorry. I'm anticipating your questions.  
16 Sorry.

02:36PM

17 Q After a couple of times --

18 A It's probably safe.

19 Q Does this TSS data and the dissolved phase  
20 data indicate that there's much affinity between the  
21 TSS and the phosphorus that's in these samples?

02:37PM

22 A It tells me that most of the samples appears  
23 to be in the dissolved phase and the TSS is low, so  
24 that's where -- the majority of the phosphorus  
25 that's in this system is in solution.

02:37PM

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1 Q So in these particular samples, you wouldn't  
2 be expected to find the adsorption process that you  
3 discuss in your expert report; is that correct?

4 MR. GEORGE: Object to form.

5 A Well, I would expect to find adsorption. I 02:37PM  
6 don't think we could avoid adsorption. I think it's  
7 less than we would find in a highly turbid or high  
8 TSS sample, higher TSS sample.

9 Q But it wouldn't be the dominant process for  
10 these samples; correct? 02:37PM

11 A No, correct.

12 Q Turn over to Page 14 and look at the USGS high  
13 flow sampling. Actually I think it's Page 15.  
14 Excuse me.

15 A So we were USGS base flow. Now we're USGS 02:38PM  
16 high flow?

17 Q Yes, sir. Okay. In this dataset, what is the  
18 TSS average?

19 MR. GEORGE: By TSS, you are referring to  
20 suspended sediment? 02:38PM

21 A Concentration --

22 Q Yes. I think we assumed that.

23 A That was my assumption. 1 -- 130.769  
24 milligrams per liter.

25 Q So does it surprise you to see that the high 02:38PM

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1 flow sample have more suspended sediments than the  
2 base flow samples for these sampling locations?

3 A No, it doesn't.

4 Q Why not?

5 A I would expect higher flow to carry more 02:38PM  
6 sediment and, therefore, be more turbid and have  
7 higher total suspended sediment concentrations.

8 Q Carry more sediment from where, sir?

9 A I would expect some sort of runoff but -- or  
10 possibly scouring of sediment in the streambed. I 02:39PM  
11 don't know but wherever you --

12 Q You would expect maybe both of those  
13 processes --

14 A Perhaps both.

15 Q Would you please identify the total and 02:39PM  
16 dissolved phosphorus results, average results for  
17 this dataset?

18 A Average results here, we're looking at about  
19 93 samples. Average for total phosphorus, 0.1756  
20 milligrams per liter; dissolved phosphorus, 0.1082 02:39PM  
21 milligrams her liter.

22 Q And did you find that to be about 60 percent?

23 A Again, your percentages seem to be reasonable  
24 estimates across the board.

25 Q Sir, if the dissolved phase fraction in these 02:39PM

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1 high flow USGS samples is about 60 percent and the  
2 dissolved phase samples in the edge of field samples  
3 is about 60 percent and the dissolved phase in all  
4 the intermediary steps were even higher, where's all  
5 the participate -- where's all the adsorption  
6 occurring in this system?

02:40PM

7 MR. GEORGE: Object to form.

8 A There were like three ifs. I'd like to make  
9 sure I understand what they were.

10 (Whereupon, the court reporter read  
11 back the previous question.)

02:40PM

12 A I would say that it's occurring in the higher  
13 total suspended solid samples that are not well  
14 represented by the calculations of these means. The  
15 mean is a univariate estimate of central tendency,  
16 and I would imagine that there are high TIS -- TSS  
17 samples on the right side of a bar graph or  
18 distribution that have high TSS that perhaps are not  
19 well represented by the averages on these tables.

02:41PM

20 Q Okay, sir. What would you have used; would  
21 you use the median?

02:41PM

22 A I would not use any univariate estimate of  
23 central tendency to characterize each of these to  
24 determine what I thought was or was not happening in  
25 the subset of samples that have high total suspended

02:42PM

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1 solids.

2 Q What would you have done to see whether or not  
3 there is actually adsorption affecting the  
4 phosphorus in the system?

5 A I would look at the samples that plot on the 02:42PM  
6 right side of the histogram of TSS, of total  
7 suspended solids, and look at the phosphorus and TSS  
8 concentrations in those samples, which is  
9 essentially what I did with these score plots that  
10 are color coded by TSS. 02:42PM

11 Q Let me ask you what the pH levels were in this  
12 particular set of samples.

13 A Which particular set?

14 Q The USGS samples.

15 A Should we start back with edge of field? Oh, 02:42PM  
16 USGS. Okay. Could you refresh my memory; what page  
17 do the USGS samples start?

18 Q Well, it would be on Page 16, the average pH  
19 levels. What's the average pH for these samples  
20 sir? 02:43PM

21 A Average pH on Page 16 for USGS high flow  
22 samples is 7.6346.

23 Q And what's the range for all that set of  
24 samples?

25 A 6.2 to 8.8. 02:43PM

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1 Q Basically in your understanding of adsorption  
2 principles would you expect there would be more  
3 affinity or less affinity for adsorption of pH  
4 levels at that rate?

5 MR. GEORGE: Object to form.

02:43PM

6 A I'm not sure. I understand that pH of the  
7 water is important to adsorption and desorption. At  
8 what point one process is favored over another as a  
9 function of pH, I can't tell you.

10 Q Can you tell us whether or not 8.8 would  
11 represent less adsorption, all other things being  
12 equal in a system, versus 6.2 pH?

02:43PM

13 A Not with confidence, no.

14 Q Let's turn over to Page 20. At the top it  
15 says Table 10 Reference Streams Base Flow.

02:44PM

16 A Yes.

17 Q Can you tell us what the total suspended  
18 solids are in the reference streams?

19 A The average is 2.7143.

20 Q And what's the range?

02:44PM

21 A One to six.

22 Q So would you characterize that as low TSS?

23 A Yes. Looking back through the tables we've  
24 gone through thus far, that's the lowest number  
25 we've had.

02:45PM

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1 Q Would you know whether or not that water at  
2 that TSS level would appear cloudy or not?

3 A I would expect it not to appear cloudy.

4 Q You're not sure about 7 TDS, but you are  
5 confident that when it gets down to 2.7, it would  
6 not appear cloudy?

02:45PM

7 A I would expect a TSS of 2.7 to plot on the  
8 left -- the far left side of this graph, and that  
9 leads me to suspect that that sample, being at the  
10 far end of that continuum, would -- I would be  
11 surprised if it was not clear.

02:45PM

12 Q Would you tell us what the total dissolved  
13 phosphorus is under method 4500 versus the total  
14 phosphorus?

15 A Total dissolved phosphorus is 0.0072.

02:46PM

16 Q All right, and what about total phosphorus?

17 A Total phosphorus is 0.0138.

18 Q Does that indicate that the dissolved fraction  
19 is around 50 percent?

20 A Yes.

02:46PM

21 Q Dr. Johnson, how do these phosphorus levels  
22 compare to the phosphorus levels from the other  
23 groups of samples we've just reviewed?

24 MR. GEORGE: All groups, David?

25 MR. PAGE: Sure.

02:46PM

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1 MR. GEORGE: Object to form.

2 A Looks to be the lowest of the ones we've  
3 discussed so far.

4 Q Would you do the same -- the same comparison  
5 for total suspended solids also, sir?

02:47PM

6 A Didn't we already do that?

7 Q I want you to compare -- I think we did look  
8 -- I compared the USGS. Did you take a review of  
9 all of them recently?

10 A For total suspended solids, I thought I did.  
11 Maybe you're thinking back to USGS.

02:47PM

12 Q Okay. If I misunderstood you, I apologize.

13 A Yes. It looks to be below total suspended  
14 solids.

15 Q And would you do the same evaluation for total  
16 suspended solids, sir?

02:48PM

17 A Unless I missed a page, it appears to be  
18 lowest.

19 Q And would the highest be the edge of field  
20 samples?

02:48PM

21 A For total dissolved?

22 Q And total suspended if you want to look at the  
23 same time, please.

24 A Yes. It appears to be highest in edge of  
25 field.

02:49PM

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1 Q You've been referencing your trend analysis.  
2 How many samples did you look at when you did your  
3 trend analysis and you evaluated the affinity  
4 between phosphorus and these --

5 MR. GEORGE: Objection, asked and answered. 02:49PM

6 MR. PAGE: I haven't even finished the  
7 question yet.

8 MR. GEORGE: Well, it's already been asked  
9 and answered. So you can ask it another time if you  
10 want to. 02:49PM

11 Q How many samples did you evaluate for your  
12 bottom trend when you did your analysis of affinity  
13 between phosphorus and particulates?

14 MR. GEORGE: Same objection.

15 A Within my report, there would have been the 02:50PM  
16 five bar graphs where I showed all the analytes.

17 Q Five samples; correct?

18 A Correct.

19 Q And the analysis that we just went through  
20 includes 2,000 samples, that is, in Appendix C, does 02:50PM  
21 it not?

22 A That's correct.

23 Q Given the high percentage of dissolved P in  
24 these types of samples, doesn't it tend to  
25 contradict your process-based explanation of PC1? 02:50PM

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1 MR. GEORGE: Object to form.

2 A Could you repeat the question?

3 (Whereupon, the court reporter read  
4 back the previous question.)

5 A Let's go back to my earlier response. I don't 02:51PM

6 know if it does or doesn't. We've gone through this  
7 exercise again looking at the average concentrations  
8 within each of these types of samples. The samples  
9 that I would expect to be on the high end of the TSS  
10 scale would also be the samples I would expect to be 02:51PM

11 farther on the right side of this plot, and I would  
12 expect that the mean TSS and TDS probably does not  
13 represent what's going on with these samples. So  
14 you may be right. I would be hesitant to agree with  
15 you unless I was allowed to go back and look at 02:52PM  
16 these data in the context of this question rather  
17 than relying on a summary table of meanings.

18 Q You're relying on the five sample analysis,  
19 are you not, sir, when you make that statement?

20 A I'm -- when I make any conclusions, I'm 02:52PM

21 relying on those five samples in conjunction with  
22 the other discussions and graphs within that  
23 section. If it's being suggested that the  
24 phosphorus data do not conclude that and it's part  
25 of some rebuttal to my report that's raised, I will 02:52PM

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1 probably go back and look at the phosphorus data in  
2 the context you are suggesting and I will do so with  
3 the whole dataset rather than averages.

4 Q Can we please turn to Page 37 and 38 of your  
5 report?

02:53PM

6 A Okay. I'm on Page 37.

7 Q Okay. Does this portion of your report  
8 support your criticism that Dr. Olsen's spatial  
9 analysis does not hold true vis-a-vis the wastewater  
10 treatment plant samples that he took?

02:54PM

11 A Yes, it does because all four of these  
12 samples, three of which were actual effluent  
13 samples, ended up with PC1 scores greater than 1.3.

14 Q Do you recall the questioning yesterday when I  
15 asked you whether you knew whether the three  
16 effluent samples included contributions from poultry  
17 processing facilities?

02:54PM

18 A I do recall that.

19 Q Okay. Do you know whether or not the Rogers  
20 wastewater treatment plant has contributions from  
21 Tysons and Ozark Mountain Poultry to its wastewater  
22 treatment plant?

02:54PM

23 MR. GEORGE: Object to form.

24 A Are we making a distinction between poultry  
25 waste and poultry litter? Are you representing that

02:54PM

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1 A That is not what I was charged to do.

2 Q Okay. What were you charged to do?

3 A I was asked to review the principal component

4 analyses of Dr. Olsen and evaluate the degree to

5 which they supported or did not support his opinions

03:23PM

6 and conclusions.

7 Q In order to complete that analysis of Dr.

8 Olsen's principal component analysis, did that

9 require you in your opinion to have characterized,

10 inventoried and described the chemical composition

03:23PM

11 of all sources in the watershed?

12 A No.

13 Q Is it your understanding, Dr. Johnson, that

14 there are other members on the defense team who are

15 involved in source identification and

03:24PM

16 characterization?

17 A Yes.

18 Q And who are those people as best you know?

19 A Tim Sullivan and John Connolly. There may be

20 others, but I know those two.

03:24PM

21 Q And did I recall correctly from your testimony

22 yesterday that both of those individuals

23 participated in a review and discussion of your

24 expert report?

25 A Yes.

03:24PM

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1 Q Okay, and at any point in time in those  
2 conversations, Dr. Johnson, did either Drs. Connolly  
3 or Sullivan suggest that your analysis was  
4 inconsistent with the work that they were doing on  
5 source identification?

03:24PM

6 A No, they did not.

7 Q Okay. Let me hand or hopefully you have in  
8 front of you Exhibits 9 and 11 to your deposition.

9 A Okay.

10 Q Do you recall being asked questions based upon  
11 a sentence or two, excerpts from Exhibit 9 titled  
12 Evaluation of Graphical and Multivariate Statistical  
13 Methods For Classification For Water Chemistry Data?

03:24PM

14 A Yes, I do.

15 Q And, Dr. Johnson, did you have an opportunity  
16 to review the entire text of that article last  
17 night?

03:25PM

18 A I still have not read it in the detail I would  
19 if I was reviewing this as a paper, but I read it  
20 and I spent more time on it than I was -- than I had  
21 here yesterday.

03:25PM

22 Q And my understanding of the questioning  
23 yesterday -- I want to know if it's consistent with  
24 yours -- was that there was a suggestion that that  
25 article supported Dr. Olsen's treatment and

03:25PM

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UNITED STATES DISTRICT COURT  
FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex. rel. W.A. DREW  
EDMONDSON, in his capacity as ATTORNEY  
GENERAL OF THE STATE OF OKLAHOMA  
and OKLAHOMA SECRETARY OF THE  
ENVIRONMENT, J. D. Strong, in his the  
capacity as the TRUSTEE FOR NATURAL  
RESOURCES FOR THE STATE OF  
OKLAHOMA,

Plaintiffs,

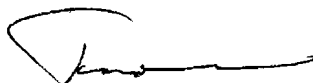
v.

TYSON FOODS, INC., TYSON  
POULTRY, INC., TYSON CHICKEN, INC.,  
COBB-VANTRESS, INC., AVIAGEN, INC.,  
CAL-MAINE FOODS, INC., CAL-MAINE  
FARMS, INC., CARGILL, INC., CARGILL  
TURKEY PRODUCTION, LLC, GEORGE'S,  
INC., GEORGE'S FARMS, INC., PETERSON  
FARMS, INC., SIMMONS FOODS, INC., and  
WILLOW BROOK FOODS, INC.,

Defendants.

Case No. 05-CV-329-GKF-SAJ

EXPERT REPORT OF



Timothy J. Sullivan, Ph.D.  
President



January 29, 2009

***the contaminants of concern within the Illinois River Watershed are phosphorus and bacteria.***

This claim was reiterated in his deposition (September 4, 2008, page 451, and again on page 516, and pages 615-616).

In EPA's revised Confined Animal Feeding Operations (CAFO) Rule, published in 2003 (U.S. EPA, 2003, page 7192), which applied in part to litter management for poultry operations defined as CAFOs, P was identified as "the pollutant of most concern". The Comprehensive Basin Management Plan for the Oklahoma portions of the IRW (Haraughty 1999, page 27) concluded that streams in the IRW are P-limited.

Most ecological concerns alleged by Plaintiffs' consultants in this case, including eutrophication of stream and lake water and reduction of dissolved oxygen, focus on aspects of water quality that Plaintiffs' consultants claim are directly or indirectly associated with concentrations of total P in surface waters. I agree with Plaintiffs' consultants Drs. Stevenson, Olsen, Fisher, Cooke, and Welch that the principal constituent of concern in the IRW is TP and that fecal indicator bacteria are also of interest. Other chemical and physical variables are either claimed to be partial components of the ecosystem response to P (for example, in some cases dissolved oxygen, chlorophyll, transparency) or are not expected to have much influence on overall ecosystem health, in comparison with P.

The existing water quality criterion for P concentration in streams classified as Scenic Rivers within the IRW is based on measurement of total P, rather than some dissolved form or a form that is expected to be especially biologically available (such as soluble reactive P, SRP, for example). For portions of the Illinois River and some of its major tributaries, the applicable water quality standard is 0.037 mg/L of TP, calculated as a geomean (geometric mean) of what would typically be at least five samples collected over a 30-day period ([http://www.oar.state.ok.us/viewhtml/785\\_45-5-19.htm](http://www.oar.state.ok.us/viewhtml/785_45-5-19.htm)). This standard applies to portions of the Illinois River and its tributaries that are designated as Scenic Rivers. Although it is possible to evaluate multiple forms of P, I focus here on total P because this is the basis for the water quality standard and because under certain conditions it is possible for P to exchange among its various forms in the environment. Although the focus is on total P, only a portion of that P is considered to be biologically available within the stream and lake systems.

Under the Clean Water Act, lakes and streams can be listed as water quality impaired, or placed on the 303(d) list, based on designated beneficial uses. Within the context of this case, one of the beneficial uses of river water that is of greatest interest is Primary Body Contact Recreation. This involves direct body contact with the water, for example when swimming, where a possibility of ingestion exists. In a lake or stream designated for the Primary Body Contact Recreation beneficial use, there are limits set for fecal indicator bacteria concentrations during the recreational period May 1st to September 30<sup>th</sup>.

Streams in Oklahoma can be listed as water quality impaired for Primary Body Contact Recreation based on one or more of three indicators of possible fecal contamination: fecal coliform bacteria (FCB), *Escherichia coli* (*E. coli*), and enterococcus. *E. coli* is a subset of FCB. In each case, the determination is made as to whether a body of water is to be listed as impaired on the basis of the geomean of a minimum of five samples collected within a period of not more than 30 days. The geomean standards for FCB, *E. coli*, and enterococcus are 200, 126, and 33 colony forming units (cfu) per 100 ml of water sample, respectively. The geomean calculation

It is well known that the land uses that are common in the IRW are often associated with contributions of nutrients such as P and fecal indicator bacteria to streams. It is also well known that it is very difficult to quantify the relative contributions from the various source types. EPA (2002, page 14) stated the following:

***Detecting and ranking sources of pollutants (to streams) can require monitoring pollutant movement from numerous potential sources, such as failing septic systems, agricultural fields, urban runoff, municipal sewage treatment plants, and local waterfowl populations. Often, states are not able to determine the particular source responsible for impairment.***

In the IRW, Plaintiffs have not conducted the monitoring identified by EPA (2002) as required to determine the particular source(s) responsible for impairment of the streams in the watershed with respect to existing water quality standards for total P and fecal indicator bacteria. However, Plaintiffs' water quality data do allow a general assessment of source areas of P and fecal indicator bacteria; concentrations of these constituents tend to be highest downstream from urban areas and WWTP facilities (see discussion in Section III.5).

Land use in the IRW includes a large amount of agricultural land, most of which is used for pasture and hay production. Urban lands also occur, and are mainly found in the upper reaches of the watershed, in the headwater areas of the Illinois River and several of its tributary streams. It is well known that watersheds having agricultural and urban land use are more likely to receive inputs of nutrients to streams and to have their drainage waters classified as eutrophic than are watersheds having forested land use (Alexander and Smith 2006).

4. *There are large numbers of people and their animals in the IRW, and Plaintiffs' consultants did not fully consider their importance as potential sources of nutrients and fecal indicator bacteria to stream waters within the watershed. Plaintiffs' consultants also did not fully consider the importance of the rapid increase in the human population that has occurred within the IRW in recent decades.*

#### Current and Recent Population Estimates

Plaintiffs' consultants largely ignored the substantial current human and cattle populations in the IRW and the extent to which the human population has been increasing in recent years, with concomitant increased potential for NPS contributions to streams.

Based on the U.S. Census, there were about 237,000 people in the IRW in the year 2000, of which approximately 160,500 lived in sewered communities, and 76,500 lived in rural areas, presumably on septic systems (Table 4-1). Such a large number of people would be expected to contribute NPS pollutants to stream waters within the watershed regardless of whether or not poultry litter had been land-applied. Pollutant sources would be expected to include bacteria and nutrients contributed via human waste (for example, from waste water treatment plant effluent, septic system drainage, leaking sewer pipes, accidental bypasses of raw sewage, land application of biosolids) and via pet waste. In addition, P can be contributed from soaps and other household products, lawn and garden fertilizer, and urban runoff from impervious surfaces (roofs, roads, sidewalks, parking lots, etc); such runoff would include nutrients and bacteria from fertilizers and animals such as birds, deer, and other wildlife, as well as pets. Roads (especially dirt roads), culverts, and stream banks from which soil-holding trees and other plants have been removed are

well-known sources of erosion. Erosion includes the movement (via water, gravity, and/or wind) of soil from the land surface to a stream. It preferentially involves movement of the smaller soil particles (especially clay size particles), and erosion can carry a substantial amount of P adsorbed to soil particles.

I estimate, using American Veterinary Medicine Association estimates for 2001 of 1.7 dogs and 2.2 cats per household in the United States (<http://www.avma.org/reference/marketstats/ownership.asp>) together with the U.S. Census estimate of 2.67 people per household (<http://www.petpopulation.org/faq.html>) and the human population estimates given in Table 4-2, that there are over 189,000 dogs and 244,000 cats in the IRW. This assumes that these national estimates are applicable to the IRW, so there is some uncertainty in these estimates. Regardless, it is clear that there are large numbers of dogs and cats in the watershed. It is also obvious that these pets are especially numerous in the upper reaches of the watershed where most of the people live. Pet waste constitutes an important potential source of fecal indicator bacteria and P to urban runoff.

It is noteworthy that developed areas, which include most of the people and therefore many of the pets that reside within the watershed, also contain relatively high percentages of impervious land, from which contaminants from pets, fertilizer application, erosion, and other sources can move rapidly and efficiently to streams. This pollutant transport pathway is accentuated by storm drains, gutters, and roadside ditches that are constructed in urban areas in order to facilitate efficient movement of water into streams during rainstorms. Such water routing infrastructure is an important tool for reducing flooding in urban areas. However, it also provides an efficient conduit for transporting contaminants from the urban landscape to streams. Waste from urban wildlife, including deer, rodents, and birds, as well as cats and dogs, can further add to the flux of contaminants to streams in the urban areas.

Defendants' expert, Dr. Clay (2008), estimated that there are approximately 199,000 cattle, 166,000 swine, 8,000 horses, and 2,000 sheep present in the watershed. Cattle, in particular, have access to streams and streamside (riparian) areas throughout the watershed. Cattle tend to spend a disproportionate amount of their time in and adjacent to streams because such areas provide a source of water, often a source of shade, and an opportunity for cooling during summer months (Clay 2008).

Plaintiffs' consultants contend that cattle do not contribute P to the IRW because they merely recycle the P that is already present in the forage that they consume. This contention reflects a complete misunderstanding of NPS pollutant transport processes. As discussed in Section III.17 of this report, the mere presence of P within the watershed reveals nothing about the propensity of that P to move into a stream; one must also consider the transport opportunities and pathways. Similarly, one cannot ignore the importance of cattle-mediated transport of P from the location of forage ingestion in a pasture directly to the stream or to the riparian area adjacent to the stream. This is critically important because P is typically not readily transported from pasture to stream. Rainfall on much of the surface of a pasture tends to infiltrate into the soil where the P can become adsorbed, rather than running off the surface as overland flow (see discussion in Section III.7 of this report). In contrast, cattle that have free access to streams can directly deposit their feces (with its P and bacteria content) into a stream or to the adjacent riparian land that may be hydrologically active, from which transport to the stream can readily occur during a rainstorm. Thus, the actions of cattle, consuming forage throughout the pasture and then preferentially depositing their feces in or near the stream, constitute an important source

***its proximity to the River and the presence of numerous pathways virtually assures that the Illinois River will be the target of and ultimate recipient of the contaminants associated with the Watts lagoon. (cited in Jarman 2008)***

It is important to note that, even though municipal sewage treatment facilities, such as WWTPs and the Watts lagoon, constitute an overwhelmingly important source of nutrients to stream water, they are not the only important sources of NPS water pollution associated with urban development. Runoff from urban areas also is well known to contribute substantial amounts of fecal indicator bacteria, nutrients, sediment, and other constituents to drainage water. Urban sources of these constituents can include fertilizer use on lawns and parks, pet and urban wildlife waste, erosion associated with construction activities, and broken or leaking sewer pipes.

Urban areas contain relatively high proportions of impervious land (i.e., parking lots, compacted soils on construction sites, roofs, roads, sidewalks, etc.), from which contaminants of all kinds can be rapidly flushed to streams during rain storms. Urban areas are specifically designed so as to move rain water quickly and efficiently to streams in order to prevent flooding. This is typically done via installation of extensive systems of storm drains, gutters, and roadside ditches. An unfortunate effect of such rapid routing of runoff into streams within urban areas is that there is much less opportunity for constituents such as P and fecal indicator bacteria, which tend to be removed from infiltrating water and retained on soils, to be removed from the runoff before it enters a stream. In urban areas, less water is routed through soils; more water is routed overland. As a consequence, proportionately more P and bacteria are carried from the land into the stream. This concept is not new; it is not specific to the IRW. Rather, it is a well-known facet of NPS pollution science. It was ignored by the Plaintiffs' consultants in this case.

Novotny (1995, page 23) concluded that urbanization is probably the greatest source of NPS pollution to streams. Nevertheless, it was not considered by Plaintiffs' consultants in targeting their sampling or interpreting much of their resulting data. Urbanization changes the hydrology of the watershed to favor transport of pollutants from the land surface to streams. Lawn fertilizers, pet waste, and urban wildlife waste are flushed into storm drains, bypassing the soils that might otherwise adsorb some of the contaminants present in that water. Soil loss to erosion from construction sites can reach magnitudes of over 100 tons per hectare per year. For that reason, construction occurring in only a small percentage of the watershed can contribute a major portion of the sediment carried by streams in the watershed (Novotny 1995, page 25). This sediment contributes directly to elevated suspended solids and turbidity; it also carries P. Novotny (1995, page 24) cautioned that newly developing urban lands (which are very common in the IRW) should receive special attention in NPS assessment:

***this stage of land is characterized by the high production of suspended solids caused by erosion of unprotected exposed soil and soil piles...Extremely high pollutant loads are produced from construction sites if no erosion control practices are implemented. Therefore, in establishing pollutant loadings relative to land uses, one must determine first whether the area is fully developed or if it is a developing area and/or significant construction activities are taking place therein.***

Novotny's caution is especially relevant to NPS pollution in the IRW. As described in Section III.3 of this report and by Grip (2008), new construction is widespread in the IRW, and northwest Arkansas has been in recent years one of the fastest growing metropolitan areas in the United States.

Often, it is not the grazing intensity on the land that determines the extent of stream water pollution associated with cattle; rather, it is the unrestricted access of cattle to water that has the major impact (Novotny, 1995, page 23). I have observed that cattle in the IRW commonly have access to streams, and that cattle access to streams appears to be more widespread on the smaller tributaries than it is along the main stem Illinois River.

It has been reported in the scientific literature that P concentrations in runoff from intensively managed dairy pasture can be as high as 7.36 mg/L (Nash and Murdoch 1997, cited in Haygarth and Jarvis 1999). Previous studies have found increased concentrations of nutrients in streams draining pasture land; for example, pasture in the Ozarks Highlands region of Missouri is associated with increased stream concentrations of nutrients, suspended solids and algal levels relative to forested areas (Perkins et al. 1998).

Cattle grazing in riparian areas can cause erosion and movement of P into stream waters. Butler et al. (2006) found that vegetative ground cover has a large impact on the volume of surface runoff and P export from pastured riparian areas. Riparian areas with bare ground contributed substantial amounts of sediment and P to surface waters during heavy rainfall.

Plaintiffs' consultant, Dr. Fisher, testified in his deposition (September 4, 2008) about an email that he received from Shannon Phillips from the Oklahoma Conservation Commission (labeled as Exhibit 27) which documented:

***elevated nutrient concentrations and dramatic increases in periphyton growth***

attributed by Ms. Phillips to cattle grazing in Cedar Hollow, a subwatershed of the IRW which was believed to not have received land application of poultry litter.

Dr. Olsen testified in the Preliminary Injunction hearing that he could discriminate among poultry, WWTP, and cattle as sources of constituents in water in the IRW, but he did not articulate a specific criterion (such as his principal component (PC) 1 equal to or greater than 1.3 cutoff that he used to determine poultry impact) to assign a water sample to the cattle impact category. Dr. Glenn Johnson (2008, pages 40 to 50) describes in detail how Dr. Olsen's arguments changed from the Preliminary Injunction stage of this case to his September, 2008 deposition. As Dr. Johnson shows, all four of Dr. Olsen's cattle-impacted samples had PC1 greater than 1.3, above his unique poultry waste signature threshold, and Dr. Olsen was unable to obtain separation in his PCA analyses between cattle and poultry impact. When confronted with new evidence regarding PCA results for samples that Dr. Olsen believed to be cattle impacted, his opinion that cattle are not an important source in the IRW never changed, only the line of reasoning that he needed to adopt to reach that conclusion. In the final analysis, it appears that Dr. Olsen believes that cattle cannot be important sources of constituents to stream water because he is unable to see a strong signal in his PCA. As described in Section III.12 and in the expert reports of Dr. Glenn Johnson, Dr. Larson, and Dr. Chadwick, Dr. Olsen's PCA is not a scientifically legitimate tool for excluding cattle, or any other potentially important nonpoint source, as significant in this watershed.

I located 11 bacterial TMDL reports that were completed for the Oklahoma DEQ and that provided an estimate of what constituted the most important source of fecal bacteria to the subject watersheds. The locations of the watersheds for which those TMDL reports have been completed are shown in Figure 6-2. Together, they cover much of the state of Oklahoma, including watersheds to the north and south of the IRW, including areas of intensive poultry

now a potential source of sediment, P, and other constituents to the Illinois River as it crosses the state line from Arkansas into Oklahoma (Haggard and Soerens 2006).

It is likely that the Lake Frances lakebed stored P in its sediments, especially during the years when P concentrations in the river were high (Haggard and Soerens 2006). This stored P can now be released back into the river when dissolved P in the water is less than equilibrium P concentrations with the sediment. In addition, resuspension of P-enriched sediment, due to wind (Søndergaard et al. 1992) or high stream flow can increase the concentration of P in stream or lake water.

Based on experiments using lake sediment cores from Lake Frances, Haggard and Soerens (2006) found that bottom sediments in Lake Frances have the ability to release phosphate into the river water. They measured sediment P fluxes under aerobic conditions that rivaled those measured under anaerobic conditions in many eutrophic reservoirs. They concluded:

***Thus, bottom sediments in Lake Frances have the potential to release high amounts of P and also to maintain P concentrations downstream at the Illinois River elevated above Oklahoma's Scenic River TP criterion (0.037 mg/L)...It is possible that remediation strategies should be considered for Lake Frances and the P- rich sediments stored within the former impoundment, if Oklahoma's Scenic River TP criterion will be achieved.***

To the best of my knowledge, Plaintiffs' consultants have not considered the influence of Lake Frances on TP concentrations in the Illinois River in any of their analyses.

Nevertheless, the potential importance of Lake Frances as a source of P to the Illinois River has been recognized for some time. The Comprehensive Basin Management Plan, prepared by the Oklahoma Conservation Commission (Haraughty 1999) stated:

***The collapse of the Lake Frances Dam in 1991 resulted in an additional source of nonpoint source pollution to the Illinois River basin in Oklahoma. The collapse exposed several hundred thousand cubic meters of nutrient-enriched lake bed to potential erosion.***

Haraughty (1999, page 53) went on to state, in discussing Lake Frances:

***It is difficult to imagine that water quality in the river can be much improved until this situation is addressed as a high potential exists for release of sediment to the river.***

The extent to which P is contributed to the Illinois River by Lake Frances was examined in a study by Parker et al. (1996). Samples of river water were collected at the Highway 59 bridge crossings above (n=130) and below (n=94; near Watts) the state line over a one year period in 1995 and 1996. Weekly samples were collected and augmented with additional storm samples. The average total P above the lake was 0.28 mg/L and below the lake it was 0.33 mg/L. Parker et al. (1996) reported that:

***The percent difference of 16.4% and t-test results of 0.059 for TP give borderline results as to whether a difference exists in the upstream and downstream TP concentrations.***

Thus, results of the statistical comparison were inconclusive. It is noteworthy, however, that the difference in the average results between the two stations was actually larger than the 0.037

mg/L water quality standard for TP. This suggests that if there were no sources of TP in Arkansas at all, the concentration of TP in the Illinois River in Oklahoma, just downstream from the Arkansas state line, might exceed the water quality standard solely on the basis of P contributed at the Lake Frances location, and the adjacent contributing area, between the two Highway 59 bridge crossings. Parker et al. did find a statistically significant increase (by 42%) in the concentration of total suspended solids (TSS) from the upstream to the downstream sampling location, supporting the hypothesis that the former Lake Frances lake sediment may be eroding and contributing sediments to the Illinois River.

Haggard and Soerens (2006) evaluated P release from sediments that had previously accumulated in Lake Frances. Haggard and Soerens (2006) stated:

***State agencies at the Arkansas-Oklahoma River Compact Commission reported conflicting trends in P concentrations and loads at the Illinois River during 2002, where P was decreasing in Arkansas and increasing in Oklahoma. One potential confounding factor in the water-quality monitoring programs between states may be that Arkansas monitors the Illinois River upstream of a small impoundment (Lake Frances) and Oklahoma monitors downstream from the spillway.***

Sediment equilibrium P concentrations in laboratory studies were found to range from 0.05 to 0.20 mg/L, which is greater than the total P standard applicable to this river from the Lake Frances outlet downstream through Oklahoma. Haggard and Soerens (2006) speculated that P that had been previously stored in the Lake Frances sediments during the years when P concentrations in river water were especially high, are now being released from sediment into the river water column. This would be expected to occur, in particular, when dissolved P in the river is less than sediment equilibrium concentrations, and when oxygen is depleted at the sediment/water interface or sedimentary P is introduced back into the water column by wind resuspension of bottom sediments. The latter process is known to occur in shallow, nutrient-rich lakes (Søndergaard, 1992). In discussing their findings, Haggard and Soerens (2006) concluded:

***This study showed the potential for bottom sediments in Lake Frances to increase P transport at the Illinois River, especially if water column dissolved P concentrations upstream from Lake Frances decrease...***

### Summary

It is clear that there are a multitude of point and nonpoint sources of P and fecal indicator bacteria to the IRW. The Oklahoma Conservation Commission's Comprehensive Basin Management Plan for portions of the IRW that occur within Oklahoma (Haraughty, 1999) stated:

***However, agriculture cannot be cited as the sole source of water quality problems in the watershed... Additional nonpoint sources include recreation, the remains of Lake Frances, urban runoff, gravel mining, and streambank erosion. Combined sources (sources with essentially both point and nonpoint source pollution) include nurseries and urban runoff.***

The importance of these, and other (i.e., pets, row crops, hobby animal husbandry), widely distributed sources is cumulative. Some may also be important individually. For example, Haraughty (1999, page xiii) concluded that a single nursery on the shores of Lake Tenkiller contributed more than 1% of the total P load to the lake in irrigation return flows alone

(Figure 10-2). This has important implications regarding how surface water fecal indicator data should be analyzed and interpreted.

Figures 10-2 and 10-3, showing different representations of the same data, collected by the same agency, from the same location illustrate a number of important points. Contrary to the highly misleading graphic offered by the Plaintiffs in the Preliminary Injunction hearing, purported to indicate an increasing trend over time in bacterial concentrations in the Illinois River, there is no indication in the USGS data that fecal indicator bacteria or total P concentrations at this site have increased over time. Rather, the large differences in concentrations recorded during the various years are mainly determined by the number of high flow samples that were collected. For years during which many high flow samples were collected, the bacteria concentration values (including the geomean of the values) were relatively high. For years during which few high flow samples were collected, the bacteria and total P concentration values were relatively low. Many more samples were collected by USGS during high flow conditions during the years post-1998 (Figure 10-4). Any representation by the Plaintiffs that such data reflect a pattern of increasing fecal indicator bacteria or total P concentration over time is not accurate.

Point sources of water pollution, such as WWTPs, contribute constituents, including P, to stream water under all flow regimes. During high flow periods, it is also possible for constituents such as P and fecal indicator bacteria to move as nonpoint source contributions from some land locations to streams. Point sources can also contribute to concentrations in stream water under high flow conditions because high flow can re-suspend P that had been deposited in the stream sediments when flows were low. This mechanism was documented by Haggard et al. (2001) in Spavinaw Creek, Arkansas. They concluded that:

*the P adsorbed to benthic [stream bottom] sediments may be resuspended into the water column and transported downstream during storm runoff events... Perhaps the most important finding in this study is the pronounced impact that Columbia Hollow [WWPT plant] has on P retention in Spavinaw Creek. P retention efficiency in Spavinaw Creek was reduced by a factor of 30 below Columbia Hollow*

Similarly, Haggard et al. (2003b, page 191) concluded that:

*Almost half of TP transported in streams during storm events may be resuspended from bottom sediments (Svendsen et al. 1995). Release or resuspension of P associated with stream sediments in the Illinois River may be a critical source because this stream receives P inputs from several wastewater treatment plants in the headwaters."*

Ekka et al. (2006, page 389) stated that:

*During storm events, dissolved and total P transport may be influenced by resuspension of point sources of pollution. Suspended sediments in streams affect dissolved P equilibrium between water and benthic sediments (House et al. 1995) and likely impact dissolved P concentrations occurring during surface runoff events in streams"*

Pickup et al. (2003), in a USGS report on P in the IRW, concluded that P concentrations generally increased with runoff, and they offered as possible explanations for this: P resuspension from the stream bed, stream bank erosion, and the addition of P from nonpoint

sources. In contrast to the interpretation of Pickup et al. (2003), one might erroneously conclude from the reports of Plaintiffs' consultants that resuspension from the stream bed, stream bank erosion, and a variety of NPS pollution sources are unimportant and nearly all NPS P is derived from poultry litter.

There are numerous temporary sinks for P in stream systems. These include P adsorption to sediment, various impoundments, and uptake from the water column by microbes and aquatic plants (cf., Haggard et al. 2004). As a consequence, some of the P that is contributed by point sources during low flow conditions can be stored in the sediment and biological communities and then remobilized into stream water if the P sources become reduced or during high stream flows (Haggard et al. 2004).

Recreational activities in the IRW (described by Plaintiffs' consultant Dr. Caneday (2008) and Defendants' consultant Dr. Dunford (2008)) are primarily those covered by secondary body contact recreation, such as wading, canoeing, boating, and fishing. The Illinois River is primarily a floating river, rather than a swimming river. The primary body contact recreation standards for fecal indicator bacteria apply to full immersion, which does occur in the IRW, but which is generally infrequent and short-lived (Dunford 2008). Secondary standards are generally five times higher than primary standards (Gibb 2008, page 11).

#### Effect of Stream Order

Streams within the watershed are commonly classified according to Strahler stream order, which reflects the relative size of the various streams. The smallest tributaries in the upper portions of the watershed are first order. As the first order stream flows downhill, it combines with other first order streams. Once two first order streams combine, they form a second order stream. The process continues in a downstream direction to higher orders (Figure 10-5). In the IRW, most streams range from first order to sixth order (Figure 10-6) based on the National Hydrography Dataset; a short segment of the Illinois River is classified here as seventh order below the confluence with the Baron Fork. First order streams tend to be very numerous and very small. In general, they were not sampled by Plaintiffs' consultants in their stream sampling efforts for this case. In Figure 10-6, I show the locations of streams within the watershed that are second order and larger. The rafting section of the Illinois River is sixth order according to this scheme.

It can be useful to break down the sampled streams within the watershed into stream order classes, because some conditions vary with stream order. For example, the geomean *E. coli* concentrations measured by Plaintiffs' consultants in the IRW tend to be higher for the smaller (lower order) streams as compared with the larger streams. The geomean from Plaintiffs' database of the measured *E. coli* concentrations in fourth, fifth, and sixth order streams are below the geomean standard for primary body contact recreation (Figure 10-7). I expect most of the stream recreation to occur on these larger streams, and they generally have lower *E. coli* concentrations than do the smaller streams where I expect less stream recreation to occur.

11. *In order for land applied P to have an ecological impact on a stream, it must be physically transported from the site of land application to the stream. P and fecal indicator bacteria are not uniformly contributed to streams via runoff from pasture lands, but rather are disproportionately contributed from hydrologically active areas. These are portions of the landscape that contribute most of the overland flow to streams during rain storms. Overland*



## **Expert Report**

# **Illinois River Watershed Water Quality and Source Assessment**

***Prepared for:***

**Illinois River Watershed Joint Defense Group**

***Prepared by:***

**Quantitative Environmental Analysis, LLC**

**Montvale, NJ**

**January 30, 2009**

UNITED STATES DISTRICT COURT  
FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex. rel. W.A. DREW  
EDMONDSON, in his capacity as ATTORNEY  
GENERAL OF THE STATE OF OKLAHOMA  
and OKLAHOMA SECRETARY OF THE  
ENVIRONMENT, J.D. Strong, in his  
capacity as the TRUSTEE FOR NATURAL  
RESOURCE FOR THE STATE OF  
OKLAHOMA,

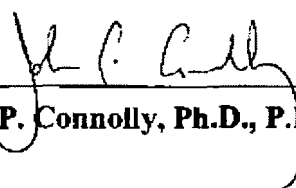
Plaintiffs,

v.

TYSON FOODS, INC., TYSON  
POULTRY, INC., TYSON CHICKEN, INC.,  
COBB-VANTRESS, INC., AVIAGEN, INC.,  
CAL-MAINE FOODS, INC., CAL-MAINE  
FARMS, INC., CARGILL, INC., CARGILL  
TURKEY PRODUCTION, LLC, GEORGE'S  
INC., GEORGE'S FARMS, INC., PETERSON  
FARMS, INC., SIMMONS FOODS INC., and  
WILLOW BROOK FOODS, INC.,  
Defendants.

Case No. 05-CV-329-GKF-SAJ

EXPERT REPORT OF

  
John P. Connolly, Ph.D., P.E., B.C.E.E.

**QEA**  
Quantitative Environmental Analysis, LLC  
2c/dt

January 30, 2009

Plaintiff's consultants in 2005 and 2006. Table 2-5 and Figure 2-12 show for these few samples the concentrations of total phosphorus, Iron (Fe), aluminum (Al), and the ratio of total phosphorus to the sum of Fe and Al. The total phosphorus concentrations range from 123 to 775 mg/kg, about a factor of six; close to the range of total phosphorus concentrations found in stream sediments (111 to 921 mg/kg by method SW6020B). Note that the samples also have a wide range of Fe + Al concentrations that vary by almost a factor of five and that the total phosphorus concentrations correlate with the Fe + Al concentrations. To account for this correlation, the total phosphorus concentrations were normalized by the sum of Fe and Al (Daskalakis and O'Connor 1995). The normalized concentrations are all very similar, ranging over a factor of two, despite the fact that the total phosphorus concentrations range over a factor of six. Most significantly, the normalized concentrations for the stream samples fall within the range of values for the three control soil samples. In fact, of the many stream samples taken by the Plaintiffs' consultants, only one has a normalized total phosphorus concentration substantively above what was found for the control pasture soils; Station SD-008 (which is not shown in Table 2-5 or Figure 2-12) had a value of 0.044. The striking conclusion from this illustration is that higher concentrations of total phosphorus are not presumptive evidence of an anthropogenic source. These higher concentrations may simply reflect the greater presence of iron and aluminum compounds (or calcium compounds) that naturally contain phosphorus or have the ability to bind phosphorus naturally present in the environment. In other words, there is no evidence that the total phosphorus concentrations in stream sediments are higher than expected from soils running off of control fields. The total phosphorus concentrations differences among the stream sediment samples are the result of differences in the concentrations of Fe and Al in the material settling to the bottom.